

## **Follow-up of the MI RF upgrade discussion of last week**

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To upgrade the MI to a 2 MW machine in the proton driver era, a major work is the RF upgrade. It needs to deliver 6 times more power to the beam and to cope with the beam-loading problem, which would be 6 times more severe. As summarized in the PD2 study report (Ch. 15 in TM-2169), it is envisioned to take two parallel paths to reach the goal. One is to upgrade the existing RF system, another to design and build a new RF system.

1. To upgrade the existing system: The main work is to add a second PA to each cavity and to increase the driver power to 22.5 kW (which is 4 kW now and will be 8 kW after the upgrade for slip stacking). This approach has the advantage of being relatively straightforward and of short lead-time. It will also help NuMI increase proton flux in the near term. The main concern is the reliability. Although Jim (G.)'s calculation shows each PA should be able to reach 400 kW with a 22.5 kW driver, the tube lifetime and maintenance could become real issues. One way to get around this problem is to add more cavities. For this Dave (C.) and I went to the tunnel for a real estate survey for new cavity locations.

MI-60 is totally full. But MI-30 is a possibility. The cavity height (from the center of the MI beamline to the top of the cavity, including the cooling tubes) is about 52", whereas the distance from the center of the MI beamline to the bottom of the heat shield of the Recycler pipe is about 54". Therefore, a cavity can fit in between the two beamlines. At this moment, there are LCW pipes there. But they can be easily relocated to the back of the wall. Another obstacle is the Recycler magnet support. If it can be redesigned, it will not be a problem. If not, one can still find a number of places where there is no support. The MI-30 has 8 sections (Q301-Q309). The E-cool uses only two (Q305-Q307). The remaining 6 sections are empty. So the bottom line is: If we want to add RF in MI-30, we can. Of course this will mean a second RF service building.

The plan is to do a dual-PA test in the MI-60 building after this shutdown. Ralph and John (R.) have agreed. Ioanis and Roger are also supportive. Most hardware (a spare cavity, PAs, modulators) is available except a new coupling loop and a dummy load. The purpose is to find out how much power can be delivered reliably with two PAs.

2. To design and build a new RF system: This is the preferred ultimate solution. The new RF will use big tubes (1 MW) and have low R/Q (25 ohm, or 1/4 of the existing RF). The problem, however, is that it will be a major undertaking and have long lead-time. Because we don't have enough resources at this moment, we will start this work immediately but only in a small scale (paper design and simulations). Dave (W.) will take up this task with the help from the RF department.